

**POTENTIAL TANNIN SUPPLIES
FROM DOMESTIC BARKS**

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It is quite generally known that our domestic production of vegetable tanning materials has been decreasing for a number of years, and that our present supplies represent only a very small part of our tannin needs. Any activity, therefore, which will result in the development of new sources of tannin either as farm crops or by the economic recovery and utilization of available but unused domestic bark supplies, will aid greatly in meeting our tannin needs. The present paper presents data which indicate that our tannin-bearing barks can play an important part in building up our domestic tannin production, provided that economic collecting, shipping and processing methods can be developed.

The Tanning Material Situation

Background information on the trends in consumption, domestic production and imports of tannin over a period of years can be obtained by a study of Tables I and II. Table I shows considerable variation in total tannin consumption between 1927 and 1950, but domestic production decreased more or less regularly from 65,847 tons of 100% tannin in 1947 to 16,935 tons in 1950.

In Table II more details concerning the tanning materials used are shown for the years 1948, 1949 and 1950. In this case it will be noted that only 15% of our tannin consumption in 1950 came from domestic sources. With such major dependence upon foreign sources of tannin, our leather industry would be in an insecure status if a national emergency should develop. Figure 1 shows clearly the downward trend in domestic tannin production since 1939 and the increase in imports.

Barks as Tannin Sources

For many years prior to the domestic use of chestnut and quebracho extracts, this country did most of its vegetable tanning with oak and hemlock bark. These made excellent leather. In recent years their use has steadily decreased, because of increased labor and transportation costs, reduced accessibility of bark supplies, and because domestic chestnut extract and imported tanning extracts were more easily handled and lower

TABLE I
Consumption, Imports and Domestic Production of Vegetable Tannins

Year	Total Consumption		Imports		Domestic Production	
	100% Tannin	% of Total	100% Tannin	% of Total	100% Tannin	% of Total
	tons*	%	tons*	%	tons*	%
1927	118,173	100	52,326	44.28	65,847	55.72
1937	122,776	100	74,343	60.55	48,433	39.45
1942	151,624	100	102,511	67.61	49,113	32.39
1944	113,425	100	80,761	71.20	32,664	28.80
1946	131,236	100	104,421	79.57	26,815	20.43
1948	134,013	100	102,851	76.75	31,162	23.25
1949	87,062	100	64,814	74.44	22,248	25.56
1950	112,029	100	95,094	84.88	16,935	15.12

* Short tons

Note - The total consumption of tannin is taken as the imports plus domestic production. No allowance has been made for exportation of tannins. The data on imports were obtained from Department of Commerce Reports on Imports for Consumption. Data on Domestic Production were obtained from Census of Manufactures or by correspondence with individual manufacturers. In the case of domestic materials, other than chestnut, actual production data were not always available; in some cases the production figures given were averages of previous years. Data for the 1946 imports were calculated from data given in Report No. FT 110, United States General Imports of Merchandise of the Department of Commerce for Calendar year 1946.

TABLE II
Relation of Domestically-Produced Tannins to Imported Tannins

	1948 %	1949 %	1950 %
<i>Domestically-Produced Tannins</i>			
Part of total consumption	23.25	25.56	15.12
From chestnut wood	20.50	21.81	12.90
oak bark	1.32	1.83	1.39
hemlock bark	1.14	1.41	.65
sumac extract12	.24	.18
pecan shell extract17	.27
<i>Imported Tannins</i>			
Part of total consumption	76.75	74.44	84.88
From quebracho extract	49.49	43.00	58.83
wattle bark and extract	16.95	23.09	16.34
mangrove bark and extract	3.00	3.00	2.88
myrobalans fruit and extract	2.70	2.36	2.27
valonia cups, beads and extract	3.19	1.36	2.01
all others	1.42	1.63	2.55

Note - Source of data for chestnut tannin was American Extract Manufacturers Association. Data on oak, hemlock, sumac and pecan shell tannins were obtained by individual correspondence with tanners and extract manufacturers. No data on production of spruce extract (sulfite cellulose extract) were obtainable.

Data on imported tannins were obtained from U.S. Department of Commerce, Census Reports No. FT-110 and calculated to the percentage values shown.

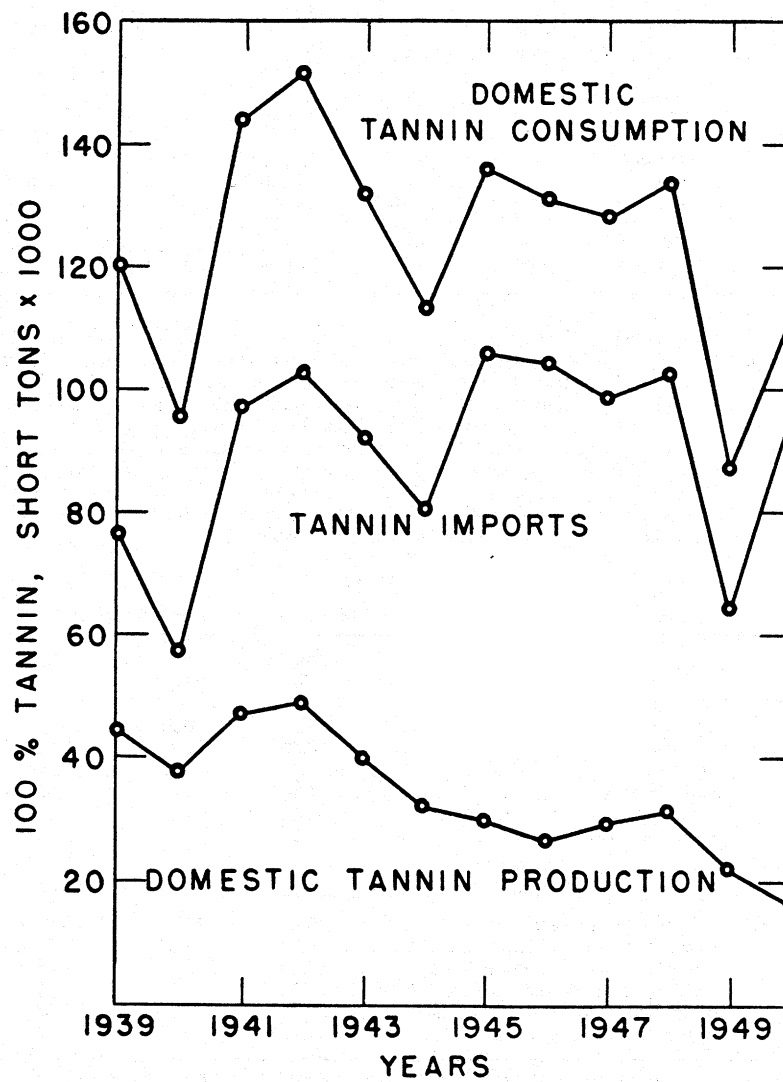


Figure 1 - Trends in Tannin Imports, Domestic Production and Domestic Consumption.

in cost. Today the domestic chestnut extract supply is approaching exhaustion and we have become almost entirely dependent upon foreign tannins and a few of the newer and more costly synthetic tannins for making our leather.

From our timber and pulp industries and from other available but unused bark sources it is estimated that there could be made available each year more than 2,500,000 tons of tannin-bearing barks. Much of this is now wasted or used for fuel. The principal barks included are those of hemlock, spruce, fir, and oak.

Barks from Northeastern Woods

Since the Northeastern Wood Utilization Council is particularly interested in the utilization of barks from this area*, let us examine these potential supplies first. A few samples of bark from Northeastern pulp mills have been analyzed for tannin. Several of these are mixtures and others evidently were low in tannin because of mill pond or other leaching action. The results of these analyses are shown in Table III.

Mr. Fred C. Simmons, Forester of the Northeastern Forest Experiment Station, has furnished data on the production of tannin-bearing barks as given in the preliminary report for 1951. During that year there were produced in the Northeastern area 3,300,000 cords of pulpwood and 2,900,000,000 board feet of sawlog lumber¹.

To calculate the quantities of bark available from these sources, the following factors were used:

1 cord of pulpwood yields 500 lbs. of air dry bark;

1000 board feet of sawlogs yield 500 lbs. of air dry bark.

Pulpwood and sawlogs calculated on this basis and allowing for 15% moisture in the bark could have provided in 1951, respectively, 701,250 and 616,250 short tons of moisture-free bark. The tannin-bearing species represent 45% of the total pulpwood species. They consist of

Maple and oak	10%
Spruce	30%
Hemlock	5%
Total pulpwood species that are tannin-bearing	45%

*The Northeastern area includes West Virginia, Virginia, Pennsylvania, Kentucky, Delaware, Maryland, New Jersey, New York, Maine, Massachusetts, Connecticut, Vermont, Rhode Island and New Hampshire.

TABLE III
Bark from Northeastern Pulp Mills
(Analyzed at Eastern Regional Research Laboratory)

<i>Botanical Name</i>	<i>Common Name</i>	<i>Source</i>	<i>Tannin Content</i>
<i>Picea rubra</i>	Spruce, red	Wilkes-Barre, Pa.	13.3
<i>Picea rubra</i> , Link	Spruce, red	Aries, N. E. states	13.0
<i>Abies balsamea</i> , Mill	Fir, balsam	Aries, N. E. states	4.1
<i>Abies balsamea</i>	Fir	Maine	3.42
	Fir	Maine	3.86
	Fir & Spruce, 60-40%	Groveton, N. H.	4.16
<i>Tsuga canadensis</i> L.	Spruce & Fir	Hollingsworth & Whitney, Boston	2.80
<i>Tsuga canadensis</i>	Hemlock, eastern	Great Northern Paper Co., Maine	4.87
<i>Populus tremuloides</i> , Michx.	Hemlock & Poplar	Aries, N. E. states	12.2
	Aspen, Quaking (Poplar)	Great Northern Paper Co., Maine	6.8
<i>Acer saccharum</i> , Marsh	Poplar (probably Quaking Aspen)	Hollingsworth & Whitney, Boston	6.2
<i>Acer saccharinum</i> , L.	Maple (Rock?) Sugar?	Aries, N. E. states	5.0
	Maple (white?) Silver	Groveton, N. H.	1.9
	Maple, Rock	Aries, N. E. states	4.87
	Maple, White	Aries, N. E. states	9.4
<i>Fagus grandifolia</i> , Ehrh.	Beech, American	Groveton, N. H.	5.47
	Beech	Aries, N. E. states	2.26
<i>Betula lutea</i> , Michx. f.	Birch, yellow	Groveton, N. H.	4.8
<i>Betula lutea</i> , Michx. f.	Birch, yellow	Aries, N. E. states	1.37
<i>Betula populifolia</i> , Marsh	Birch, silver	Groveton, N. H.	3.1
<i>Betula papyrifera</i> , Marsh	Birch, white, paper	Aries, N. E. states	1.49
	Birch, white	Groveton, N. H.	5.3
<i>Pinus strobus</i> , L.	Cherry, black	Aries, N. E. states	3.2
	Pine, white	Groveton, N. H.	1.64
	Pine, loblolly	Aries, N. E. states	3.25
	Pine, shortleaf	Canton, N. C.	6.0
	Pine, Virginia	Canton, N. C.	5.58
	Pine	Canton, N. C.	11.42
	Loose Bark (run of the mill)	W. Va. Pulp & Paper Co.	8.61
	Loose Bark (run of the mill)	Groveton, N. H.	3.22
		Groveton, N. H.	2.20
			2.80

The tannin-bearing species represent 37% of the total sawlog species, and these consist of

Maple and oak	20%
Spruce	4%
Hemlock	13%
Total sawlog species that are tannin-bearing	37%

Since both the oak and maple barks come from several different species and the proportions and tannin contents are not known, estimation of the potential quantity of tannin that might be recovered from these barks will not be undertaken.

Of the 701,250 tons of moisture-free bark from pulpwood, spruce bark represents 30% and is assumed to contain 13% tannin. On this basis, the spruce bark from pulpwood represents a potential tannin yield of 27,349 short tons of 100% tannin.

In the same manner 5% of the 701,250 tons of pulpwood bark would give the number of tons of hemlock bark available, and this at 12% tannin would indicate a potential hemlock tannin yield of 4,207 tons of 100% tannin.

Using the same procedure, tannin was calculated from the 616,250 tons of moisture-free bark from the sawlogs. The potential tannin yields from spruce and hemlock barks, respectively, were 3,204 and 9,613 tons of 100% tannin.

Summarizing the potential tannin available in spruce and hemlock barks in the Northeastern area, we have a total of 44,374 tons of 100% tannin. If it is assumed that an extraction efficiency of 80% could be attained and that all the bark from spruce and hemlock that become available had been used, there could have been a potential tannin recovery of approximately 35,499 tons of 100% tannin for 1951. This represents more than one-fourth of our annual tannin requirement.

Barks from Florida Scrub Oaks

There are some 20 or more species of scrub oaks in Florida. The most important are: Turkey oak, *Quercus laevis*; blackjack oak, *Q. marilandica*; and bluejack oak, *Q. cinerea*. These, together with the other minor species, have been estimated to occupy between 5000 (May and Frahm)³ and 8000 (Heyward)³ square miles in Florida alone. Turkey oak is the predominating and most important species. We have made a study of the tannin content of a comprehensive series of turkey oak bark samples and

have found that this bark, when moisture-free, contains an average of 10.5% tannin². It has been estimated by Calderwood and May³, that if this bark were cut on a sustained yield basis it would furnish sufficient bark for the operation of 3 tanning extract plants, each producing 160 (500 lb.) barrels of 25% tanning extract per day, or a total of 7,500 tons of 100% tannin in a 250-day year.

Barks from Tennessee Valley Oaks

The most important of the several species of oak occurring in the Tennessee Valley are: White oak, *Quercus alba*, black oak, *Q. velutina*, southern red oak, *Q. falcata*, chestnut oak, *Q. montana*, northern red oak, *Q. borealis*, blackjack oak, *Q. marilandica*, scarlet oak, *Q. coccinea* and post oak, *Q. stellata*.

The tannin contents of the pure barks from these species (See Table IV) vary from 5.4 to 16.0%. When composited in approximately the proportion in which they occur, we found that the average tannin content of the bark mixture was 8.6% on the moisture-free bark⁴. Bailey and Cummings of T.V.A., have reported⁵ that approximately 128,000 cords of oak slabs are produced annually in that area and that each cord of slabs weighs about 3,750 lbs. and contains 42% by weight of bark. At 15% moisture, 8.6% tannin and 80% leaching efficiency, 128,000 cords of

TABLE IV

Analyses of Samples of Pure Oak Barks Collected in the
Tennessee Valley by Representatives of T. V. A.

		Tannin % Moisture-Free Basis
<i>Quercus alba</i>	White Oak	6.1
<i>Quercus alba</i>	White Oak	6.6
<i>Quercus velutina</i>	Black Oak	9.3
<i>Quercus velutina</i>	Black Oak	9.2
<i>Quercus montana</i>	Chestnut Oak	15.3
<i>Quercus montana</i>	Chestnut Oak	16.0
<i>Quercus coccinea</i>	Scarlet Oak	7.1
<i>Quercus coccinea</i>	Scarlet Oak	10.6
<i>Quercus stellata</i>	Post Oak	7.4
<i>Quercus stellata</i>	Post Oak	7.1
<i>Quercus marilandica</i>	Blackjack Oak	9.2
<i>Quercus marilandica</i>	Blackjack Oak	8.8
<i>Quercus falcata</i>	Southern Red Oak	9.9
<i>Quercus falcata</i>	Southern Red Oak	9.7
<i>Quercus borealis</i>	Northern Red Oak	5.4
<i>Quercus borealis</i>	Northern Red Oak	6.4

Note - Each sample was a composite collected from 10 trees. The two samples from each species were collected at different times.

slabs would represent a potential annual yield of 5,894.8 tons of 100% oak bark tannin.

Barks from Michigan Hemlock

Eastern hemlock, *Tsuga canadensis*, produces a bark that contains about 12-14% tannin when moisture-free⁶. An examination of the potential supplies indicates that an appreciable quantity of this bark might be salvaged and converted into tanning extract if the bark from the hemlock timber cut each year in the Lake States Region were recovered and utilized. Workers at the Michigan College of Mining and Technology have studied the potential supplies of hemlock bark in that area. They have reported⁷ that there could have been produced from the upper Michigan Peninsula a maximum of 125,000 cords of bark in 1946. Their estimate was based on peeling all of the hemlock timber cut and obtaining $\frac{1}{4}$ cord of bark per cord of pulpwood and 2 cords of bark per 1000 board feet of sawlogs. They state that "There does not seem to be any reasonable doubt that one or more 40-cord extract plants could be supplied from peeled bark or by recovery from sawmill slabs." It appears, however, that there should be adequate bark to supply from 2 to 4 extract plants, each requiring 12,000 cords annually. Assuming that two such plants could be operated, they should produce annually a total of 2000 tons of 100% tannin. The growth of hemlock in this region, estimated at 14.7 million cubic feet, equivalent to 49,000 cords of bark, should furnish a continuous bark supply of more than 24,000 cords annually.

Bark from Western Hemlock

Western hemlock, *Tsuga heterophylla*, produces a bark containing, on a moisture-free basis, an average of about 15.5% tannin⁸. The U. S. Department of Agriculture, Forest Service, reported that in 1946 the sawlogs of western hemlock cut in western Oregon and western Washington totaled 1,465,540,000 board feet. Using a factor of 4,350 board feet equal to 1 short ton of air dry (15% H₂O) bark this would equal 286,370 tons of M. F. bark. This, at 15.5% tannin and a leaching efficiency of 80%, would represent a potential supply of more than 35,500 tons of 100% hemlock tannin.

Bark from Sitka Spruce

Sitka spruce, *Picea sitchensis*, which is usually associated with western hemlock and Douglas fir, produces a thin bark which, by itself, probably would not justify collection and processing. However, this bark is quite high in tannin and might be used advantageously in blends with hemlock

and fir. Thirty-one samples examined at ERRL in 1941 showed tannin ranging from 11.2 to 37.2 percent and averaging 24.1 percent⁹. The average annual cut of Sitka spruce (1948-49-50)¹⁰ was 241 million board feet log scale. Using a conversion factor of 460 lbs. of air-dry bark for every 1,000 board feet log scale, this would give an average annual production of 55,430 short tons of air-dry Sitka spruce bark. On the basis of 15% moisture, 20% tannin and an 80% extraction efficiency, this would indicate that there is potentially available annually more than 7,500 tons of 100% Sitka spruce tannin.

Bark from California Tan Bark Oak

The bark from California tan bark oak, *Quercus densiflora*, has been used in the past for tanning. This bark contains in the neighborhood of 20% tannin and, if economically feasible, could be again used to aid in meeting domestic tannin needs. It has been reported that there are 3 million acres with stands of about 20 trees per acre.

Bark from Douglas Fir

Douglas fir, *Pseudotsuga taxifolia*, is native to Oregon and Washington. The Oregon Forest Products Laboratory and the Department of Chemistry, Oregon State College, have investigated Douglas fir bark and found that it contains a condensed type tannin which ranges from 7.6 to 18.3%, depending upon the location of the sample and age of the tree¹¹. They found that this bark also contains appreciable quantities of wax and dihydroquercetin.

The average cut of Douglas fir in western Washington and western Oregon for the years 1948-49-50 was 7,237 million board feet log scale. At 520 lbs. of air-dry bark for each 1,000 board feet log scale, this is equivalent to 3,763 million lbs. of air-dry bark. At 15% moisture, 10% tannin and an 80% leaching efficiency, this is equivalent to 127,950 tons of 100% fir tannin. This amount would be potentially available annually.

The Weyerhaeuser Timber Company is investigating products that may be recovered from Douglas fir bark, including tannin and other valuable products. Their present experimental unit, although small, is giving sufficient material for market exploration. They stated that their new pilot plant will not get into operation before the end of 1952. Its output will be sufficient to furnish customers with material for exhaustive trials. The tannin content of the extract will be 50% or higher and the price will be competitive with commercial tanning extracts on the market.

Quantity of Bark Required to Operate a Tanning Extract Plant

Based on statements made by 3 experienced commercial tanning extract manufacturers, there should be available of barks such as:

Oak	10-12%	tannin, M.F. basis
Hemlock	10-13%	" " "
Mixed barks	8-10%	" " "

quantities ranging from 5,000 to 12,500 tons per year. Barks with the higher tannin content might be acceptable for lower capacity plants. Mixed barks with the lower tannin contents would doubtless require the larger quantities of bark for economic operation. In general, barks or bark mixtures with less than 8% tannin should not be considered.

Can the Barks from Northeastern Woods be Successfully Used as a Source of Tannin?

There are five factors which will determine in large degree whether it will be feasible to utilize the barks in this Northeastern area for the production of tanning extract. These are: the tannin content of the barks, the quantities of bark available, the distribution of the tannin-bearing barks, the cooperative efforts directed to the bark segregation and utilization problem, and the establishment and operation of extraction plants.

Based on a very limited number of analyses of bark samples, it appears that spruce and hemlock are the most important bark sources of tannin in this area, but oaks and maples deserve further study. With the tannin contents shown for spruce and hemlock and the overall production figures available, it appears that there is a sufficient quantity of these barks to justify the operation of more than one tanning extract plant. Although there appears to be enough bark, the really serious economic question is one of segregation of spruce and hemlock barks from other barks of low tannin content and the delivery of these barks at central locations where the extract can be made. If this can be done economically the prospect for extract production will be greatly improved. Another major problem to be met is the financing, establishing and operating of the extract plants. This might be accomplished by enlisting present extract manufacturers in the project or by means of a cooperative organization of the pulp and timber companies.

It is possible that additional supplies of tannin might be obtained from the barks of oaks and maples. It is known that barks from some of these species contain sufficient tannin to justify extraction, but information is not available at this time which indicates whether or not these materials could be collected and utilized economically.

Summary

Summarizing the various potential tannin production figures, we have the following:

<i>Barks</i>	<i>Available but Unused Domestic Tannins - Tons of 100% Tannin</i>
Northeastern spruce and hemlock	35,499
Florida scrub oaks	7,500
Tennessee Valley oaks	5,895
Michigan hemlock	2,000
Western hemlock	35,500
Sitka spruce	7,500
Douglas fir	127,950
Total	221,844 tons of 100% tannin

Of the above potential tannin supplies, some are more promising than others. The Northeastern spruce and hemlock, the Florida scrub oaks, the Tennessee Valley oaks and the Michigan hemlocks are located much nearer the center of the tanning industry than are the Western barks and would, for that reason, not entail so much in cost of transportation. The possible successful use of Western barks such as hemlock will probably also depend upon a change in present handling operations such as salt water flotation of logs, since such handling leaches out much of the tannin and contaminates that remaining with salt.

It is known that practically none of these barks are being salvaged and used as sources of tannin at present and it is probable that much of this bark cannot be utilized economically. However, if one-fourth of the amount of tannin shown can be salvaged it will aid materially in reducing this country's dependence upon foreign tannins.

It is not expected that all of this country's tannin requirements can be met by use of domestic barks, but a considerable part can come from this source. Other domestically produced materials such as canaigre and sumac are under study and can be used to raise domestic tannin production to a point where we will produce more than half of the tannin that we use.

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